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### 1) Scientific Perspectivism in Secondary-School Chemistry Education: Integrating Concepts and Skills in Chemical Thinking

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* Processed: 2020-8

The importance of learning chemical ways of thinking is widely recognized. Various frameworks have been developed to address the essence of chemistry and chemical thinking. However, very few studies have focused on how chemical ways of thinking can be defined. To elaborate chemical ways of thinking, this paper draws on scientific perspectivism (Giere 2010; Wimsatt 2007; Thagard 2012). Scientific perspectivism states that, within each general domain, several broadly accepted theoretical models exist side by side. These general theoretical models, or theoretical perspectives, determine which research questions are generated, which types of models are developed, and which criteria are important for evaluating models. A theoretical perspective can be captured in a core reasoning that embodies the fundamental relationship between model and the “real world.” Starting with their most basic form, perspectives can be used in learning how to reason about all types of ill-structured problems, directing and organizing knowledge development, and integrating knowledge and skills. The study is part of a research project on how perspectivism can be applied to the design of secondary-school chemistry education. This particular study concerns the identification, elaboration, and validation of four chemical perspectives for secondary-school chemistry education. We use these perspectives to indicate the consequences of taking a perspectivism approach to a curriculum framework. We conclude with discussing the consequences for secondary chemistry curriculum.

### 2) Electronic Structure Engineering Achieved via Organic Ligands in Silicon Nanocrystals

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* Chemistry of Materials
* https://doi.org/10.1021/acs.chemmater.0c00443
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* Published 11 Aug 2020 (early online 28 May 2020)
* Processed: 2020-8

A class of important semiconductors, such as Si, Ge, or C, has an indirect band gap, which critically limits their optical properties. Lack of efficient emission is especially unfortunate for silicon, where Si light sources could enable realization of the long-awaited on-chip-integrated Si laser for an integrated optical computing CPU architecture. Hence, methods toward the improvement of optical properties of Si-based materials are in high demand. Unlike most of the applied light-emitting semiconductor nanocrystals (NCs) with a direct band gap, the radiative rate in covalent silicon NCs (SiNCs) is size-dependent but remains low even for the smallest SiNCs. Additionally, the radiative rate is also ligand-sensitive, and the covalent bond with ligands is very rigid and static and could be, in principle, used for straining via steric hindrance, further influencing the radiative rates. In this work, we use the self-consistent density functional theory (DFT) simulation together with a "fuzzy"band-structure concept to show the effect of covalently bonded ligands on the electronic structure of NCs and their k - -space projection. For instance, in 2 nm large SiNCs with C-linked organic ligands, we demonstrate that radiative rates can be manipulated by ligands to a considerable extent through an intricate interplay between charge transfer from the core to the ligand, orbital delocalization, and strain by steric hindrance. We propose that the tunability of electronic properties achieved via ligands in covalent systems offers a possible direction toward the design of an ideal Si light-emitting system.

### 3) Shifting Towards αVβ6 Integrin Ligands Using Novel Aminoproline-Based Cyclic Peptidomimetics

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* Chemistry - A European Journal
* https://doi.org/10.1002/chem.202002554
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* Published 21 Oct 2020 (early online 7 Jul 2020)
* Processed: 2020-10

In recognition of the key role played by integrins in several life-threatening dysfunctions, the search for novel small-molecule probes that selectively recognize these surface receptors is still open and widely pursued. Inspired by previously established aminoproline (Amp)-RGD based cyclopeptidomimetics with attracting αVβ3 integrin affinity and selectivity, the design and straightforward synthesis of 18 new AmpRGD chemotypes bearing additional structural variants were herein implemented, to shift toward peptide-like αVβ6 integrin targeted binders. The ligand competence of the synthesized products toward αVβ6 was evaluated in competitive binding assays on isolated receptors, and αVβ6/αVβ3 selectivity was determined for a subgroup of compounds, resulting in the identification of four very promising candidates. SAR considerations and docking simulations allowed us to appreciate the key structural features responsible for the observed activity.

### 4) Perspectives for Teaching About How Science Works

* Janssen, F., Westbroek, H., Landa, I., van der Ploeg, B., van Muijlwijk-Koezen, J. E.
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* None
* https://doi.org/10.1007/978-3-030-57239-6\_14
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* Published 2020 (early online None)
* Processed: 2020-8

An integrative, perspective-directed, and practical approach to teaching the nature of science is elaborated in this contribution. The approach is integrative in the sense that students reflect on general and domain-specific aspects of knowledge development. In order to do this, students contribute to knowledge development using domain-specific perspectives that guide them in formulating questions as well as answers and criteria to assess those answers. The approach is practical in the sense that three heuristics were developed that offer teachers practical design support for redesigning their regular lessons into integrative, perspective-based lessons.

### 5) Iso

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* Genome Biology and Evolution
* https://doi.org/10.1093/gbe/evaa171
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* Published Sep 2020 (early online 28 Aug 2020)
* Processed: 2020-9

Xpressor: A Tool to Assess Transcriptional Activity within choresGenomes are characterized by large regions of homogeneous base compositions known as isochores. The latter are divided into GC-poor and GC-rich classes linked to distinct functional and structural properties. Several studies have addressed how isochores shape function and structure. To aid in this important subject, we present Xpressor, a tool designed for the analysis of the functional property of transcription within isochores. Xpressor allows users to process RNA-Seq data in relation to the isochores, and it can be employed to investigate any biological question of interest for any species. The results presented herein as proof of concept are focused on the preimplantation process in Homo sapiens (human) and Macaca mulatta (rhesus monkey).

### 6) Improving the Environmental Risk Assessment of Substances of Unknown or Variable Composition, Complex Reaction Products, or Biological Materials

* Salvito, D., Fernandez, M., Jenner, K., Lyon, D. Y., de Knecht, J., Mayer, P., MacLeod, M., Eisenreich, K., Leonards, P., Cesnaitis, R., León-Paumen, M., Embry, M., Déglin, S. E.
* E&H: Environmental Bioanalytical Chemistry, AIMMS, Research Institute for Fragrance Materials Inc., Environment and Climate Change Canada, Givaudan, Shell Oil, National Institute of Public Health and the Environment, Technical University of Denmark, Stockholm University, United States Environmental Protection Agency, European Chemicals Agency, ExxonMobil Biomedical Sciences Inc., Health and Environmental Sciences Institute
* Environmental toxicology and chemistry
* https://doi.org/10.1002/etc.4846
* Corresponding author: Déglin, S. E.
* Published 1 Nov 2020 (early online 11 Aug 2020)
* Processed: 2020-11

Substances of unknown or variable composition, complex reaction products, or biological materials (UVCBs) pose unique risk assessment challenges to regulators and to product registrants. These substances can contain many constituents, sometimes partially unknown and/or variable, depending on fluctuations in their source material and/or manufacturing process. International regulatory agencies have highlighted the difficulties in characterizing UVCBs and assessing their toxicity and environmental fate. Several industrial sectors have attempted to address these issues by developing frameworks and characterization methods. Based on the output of a 2016 workshop, this critical review examines current practices for UVCB risk assessment and reveals a need for a multipronged and transparent approach integrating whole-substance and constituent-based information. In silico tools or empirical measurements can provide information on discrete and/or blocks of UVCB constituents with similar hazard properties. Read-across and/or whole-substance toxicity and fate testing using adapted emerging methods can provide whole-substance information. Continued collaboration of stakeholders representing government, industry, and academia will facilitate the development of practical testing strategies and guidelines for addressing regulatory requirements for UVCBs. Environ Toxicol Chem 2020;39:2097–2108.

### 7) Comparative metathermodynamic description of thermal and correlation electron effects

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* Theoretical Chemistry, AIMMS
* Physical Review A
* https://doi.org/10.1103/PhysRevA.102.032806
* Corresponding author: None
* Published 8 Sep 2020 (early online None)
* Processed: 2020-9

Unified metathermodynamic description of thermal and correlation electron effects is proposed. It is based on the temperature-dependent populations of the common for all temperatures basis states of the (formally accurate) configuration interaction (CI) expansion of the components of the canonical ensemble. These populations are incorporated into the effective ensemble of the metathermodynamic approach through the partial effective tem- peratures. The extended temperature Te is introduced as the statistical average of those temperatures. The absolute zero of the Te scale represents a "no-correlation"Hartree-Fock state, while elevated Te describes the increase of the "correlation motion"and the conventional thermal motion. The diagonal double configuration interaction (DDCI) approximation is considered, in which the proposed metathermodynamic description of thermal and correlation electron effects is based on the temperature-dependent orbital populations.

### 8) Combining density-based dynamical correlation with a reduced-density-matrix strong-correlation description

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* Theoretical Chemistry, AIMMS, National Taiwan University
* Physical Review A
* https://doi.org/10.1103/PhysRevA.102.032815
* Corresponding author: None
* Published 15 Sep 2020 (early online None)
* Processed: 2020-9

A combined density and density-matrix functional method is proposed for the calculation of potential energy curves of molecular multibond dissociation. Its density-matrix part, a pair-density functional, efficiently approximates the ab initio pair density of the complete active space (CAS) method. The corresponding approximate on-top pair density Π is employed to correct for double counting in the correlation energy functional. The proposed ELS+ method, which augments the extended Löwdin-Shull (ELS) density-matrix functional with the Π-based scaled density functional, closely reproduces potential curves of the paradigmatic multibond dissociation in N2, H2O, and H2CO molecules calculated with the recently proposed CASΠDFT [CAS augmented with the Π-based scaled correlation correction of density functional theory (DFT)] method. Furthermore, with the additional correction for the intrafragment correlation between the broken-bond electrons, ELS++ reproduces well the benchmark potential curve of the N2 molecule by Lie and Clementi.

### 9) Hazardous compounds in recreational and urban recycled surfaces made from crumb rubber. Compliance with current regulation and future perspectives

* Celeiro, M., Armada, D., Dagnac, T., de Boer, J., Llompart, M.
* Environment and Health, AIMMS, University of Santiago de Compostela, Agronomic Research Centre (AGACAL-CIAM) – Unit of Organic Contaminants
* Science of the Total Environment
* https://doi.org/10.1016/j.scitotenv.2020.142566
* Corresponding author: Llompart, M.
* Published 10 Feb 2021 (early online 29 Sep 2020)
* Processed: 2021-9

Crumb rubber obtained from scrap tires is greatly employed for the construction of different facilities for sport, recreational and other uses. However, in recent years the concern about their safety and the related adult and children exposure to these surfaces is growing. This study aims a thorough chemical characterization encompassing 42 hazardous compounds, including polycyclic aromatic hydrocarbons (PAHs), phthalates, adipates, antioxidants and vulcanization agents in a wide range of crumb rubber from different surfaces. For the extraction of the target compounds, a method based on ultrasound-assisted extraction followed by gas chromatography-tandem mass spectrometry (UAE-GC–MS/MS) has been validated. Forty crumb rubber samples coming from synthetic turf football pitches, outdoor and indoor playgrounds, urban pavements, commercial tiles and granulates, and scrap tires, were analyzed. In addition, green alternative materials, such as sand and artificial turf based on cork granulate infill were included to compare the levels of the target compounds with those of crumb rubber. Most of the analyzed recycled surfaces meet the recent limits proposed by the European Commission for rubber granulates and mulches, although they exceed in several cases the maximum levels allowed for rubber consumer products. Besides, most of the other target compounds, including several of them considered as endocrine disruptors, were detected in the analyzed samples, reaching parts per million concentrations.

### 10) Probing Halogen-πversus CH-πInteractions in Molecular Balance

* Jian, J., Poater, J., White, P. B., Mckenzie, C. J., Bickelhaupt, F. M., Mecinović, J.
* Theoretical Chemistry, AIMMS, Chemistry and Pharmaceutical Sciences, University of Southern Denmark, Radboud University Nijmegen
* Organic letters
* https://doi.org/10.1021/acs.orglett.0c02773
* Corresponding author: None
* Published 29 Sep 2020 (early online 29 Sep 2020)
* Processed: 2020-9

Molecular balances based on the dibenzobicyclo[3.2.2]nonane template enable probing of the competition between halogen-πand CH-πinteractions. Structural, NMR spectroscopic, and computational analyses revealed that the πsystem can favorably interact both with C-X or C-H functionalities, depending on the size of the functional group.

### 11) Posttranslational insertion of small membrane proteins by the bacterial signal recognition particle

* Steinberg, R., Origi, A., Natriashvili, A., Sarmah, P., Licheva, M., Walker, P. M., Kraft, C., High, S., Luirink, J., Shi, W. Q., Helmstädter, M., Ulbrich, M. H., Koch, H. G.
* AIMMS, Molecular Microbiology, University of Freiburg, Ball State University, University of Manchester
* PloS Biology
* https://doi.org/10.1371/journal.pbio.3000874
* Corresponding author: Koch, H. G.
* Published 30 Sep 2020 (early online None)
* Processed: 2020-9

Small membrane proteins represent a largely unexplored yet abundant class of proteins in pro- and eukaryotes. They essentially consist of a single transmembrane domain and are associated with stress response mechanisms in bacteria. How these proteins are inserted into the bacterial membrane is unknown. Our study revealed that in Escherichia coli, the 27- amino-acid-long model protein YohP is recognized by the signal recognition particle (SRP), as indicated by in vivo and in vitro site-directed cross-linking. Cross-links to SRP were also observed for a second small membrane protein, the 33-amino-acid-long YkgR. However, in contrast to the canonical cotranslational recognition by SRP, SRP was found to bind to YohP posttranslationally. In vitro protein transport assays in the presence of a SecY inhibitor and proteoliposome studies demonstrated that SRP and its receptor FtsY are essential for the posttranslational membrane insertion of YohP by either the SecYEG translocon or by the YidC insertase. Furthermore, our data showed that the yohP mRNA localized preferentially and translation-independently to the bacterial membrane in vivo. In summary, our data revealed that YohP engages an unique SRP-dependent posttranslational insertion pathway that is likely preceded by an mRNA targeting step. This further highlights the enormous plasticity of bacterial protein transport machineries.

### 12) Understanding alkali metal cation affinities of multi-layer guanine quadruplex DNATo gain better understanding of the stabilizing interactions between metal ions and DNA quadruplexes, dispersion-corrected density functional theory (DFT-D) based calculations were performed on double-, triple- and four-layer guanine tetrads interacting with alkali metal cations. All computations were performed in aqueous solution that mimics artificial supramolecular conditions where guanine bases assemble into stacked quartets as well as biological environments in which telomeric quadruplexes are formed. To facilitate the computations on these significant larger systems, optimization of the DFT description was performed first by evaluating the performance of partial reduced basis sets. Analysis of the stabilizing interactions between alkali cations and the DNA bases in double and triple-layer guanine quadruplex DNA reproduced the experimental affinity trend of the order Li+< Rb+ < Na+ < K+. The desolvation and the size of alkali metal cations are thought to be responsible for the order of affinity. Nevertheless, for the alkali metal cation species individually, the magnitude of the bond energy stays equal for binding as first, second or third cation in double, triple and four-layer guanine quadruplexes, respectively. This is the result of an interplay between a decreasingly stabilizing interaction energy and increasingly stabilizing solvation effects, along the consecutive binding events. This diminished interaction energy is the result of destabilizing electrostatic repulsion between the hosted alkali metal cations. This work emphasizes the stabilizing effect of aqueous solvent on large highly charged biomolecules.General information

* Nieuwland, C., Zaccaria, F., Fonseca Guerra, C.
* AIMMS, Theoretical Chemistry
* Physical chemistry chemical physics : PCCP
* https://doi.org/10.1039/d0cp03433a
* Corresponding author: None
* Published 30 Sep 2020 (early online None)
* Processed: 2020-9

Understanding alkali metal cation affinities of multi-layer guanine quadruplex DNATo gain better understanding of the stabilizing interactions between metal ions and DNA quadruplexes, dispersion-corrected density functional theory (DFT-D) based calculations were performed on double-, triple- and four-layer guanine tetrads interacting with alkali metal cations. All computations were performed in aqueous solution that mimics artificial supramolecular conditions where guanine bases assemble into stacked quartets as well as biological environments in which telomeric quadruplexes are formed. To facilitate the computations on these significant larger systems, optimization of the DFT description was performed first by evaluating the performance of partial reduced basis sets. Analysis of the stabilizing interactions between alkali cations and the DNA bases in double and triple-layer guanine quadruplex DNA reproduced the experimental affinity trend of the order Li+< Rb+ < Na+ < K+. The desolvation and the size of alkali metal cations are thought to be responsible for the order of affinity. Nevertheless, for the alkali metal cation species individually, the magnitude of the bond energy stays equal for binding as first, second or third cation in double, triple and four-layer guanine quadruplexes, respectively. This is the result of an interplay between a decreasingly stabilizing interaction energy and increasingly stabilizing solvation effects, along the consecutive binding events. This diminished interaction energy is the result of destabilizing electrostatic repulsion between the hosted alkali metal cations. This work emphasizes the stabilizing effect of aqueous solvent on large highly charged biomolecules.

### 13) Exploring metal availability in the natural niche of Streptococcus pneumoniae to discover potential vaccine antigens

* van Beek, L. F., Surmann, K., van den Berg van Saparoea, H. B., Houben, D., Jong, W. S., Hentschker, C., Ederveen, T. H., Mitsi, E., Ferreira, D. M., van Opzeeland, F., van der Gaast–de Jongh, C. E., Joosten, I., Völker, U., Schmidt, F., Luirink, J., Diavatopoulos, D. A., de Jonge, M. I.
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* Virulence
* https://doi.org/10.1080/21505594.2020.1825908
* Corresponding author: van Beek, L. F.
* Published 5 Oct 2020 (early online None)
* Processed: 2020-10

Nasopharyngeal colonization by Streptococcus pneumoniae is a prerequisite for pneumococcal transmission and disease. Current vaccines protect only against disease and colonization caused by a limited number of serotypes, consequently allowing serotype replacement and transmission. Therefore, the development of a broadly protective vaccine against colonization, transmission and disease is desired but requires a better understanding of pneumococcal adaptation to its natural niche. Hence, we measured the levels of free and protein-bound transition metals in human nasal fluid, to determine the effect of metal concentrations on the growth and proteome of S. pneumoniae. Pneumococci cultured in medium containing metal levels comparable to nasal fluid showed a highly distinct proteomic profile compared to standard culture conditions, including the increased abundance of nine conserved, putative surface-exposed proteins. AliA, an oligopeptide binding protein, was identified as the strongest protective antigen, demonstrated by the significantly reduced bacterial load in a murine colonization and a lethal mouse pneumonia model, highlighting its potential as vaccine antigen.

### 14) An Optimal Transport Approach for the Schrödinger Bridge Problem and Convergence of Sinkhorn Algorithm

* Marino, S. D., Gerolin, A.
* Theoretical Chemistry, AIMMS, Scuola Normale Superiore di Pisa, University of Genoa
* Journal of Scientific Computing
* https://doi.org/10.1007/s10915-020-01325-7
* Corresponding author: Gerolin, A.
* Published 1 Nov 2020 (early online 19 Oct 2020)
* Processed: 2020-11

This paper exploit the equivalence between the Schrödinger Bridge problem (Léonard in J Funct Anal 262:1879–1920, 2012; Nelson in Phys Rev 150:1079, 1966; Schrödinger in Über die umkehrung der naturgesetze. Verlag Akademie der wissenschaften in kommission bei Walter de Gruyter u, Company, 1931) and the entropy penalized optimal transport (Cuturi in: Advances in neural information processing systems, pp 2292–2300, 2013; Galichon and Salanié in: Matching with trade-offs: revealed preferences over competing characteristics. CEPR discussion paper no. DP7858, 2010) in order to find a different approach to the duality, in the spirit of optimal transport. This approach results in a priori estimates which are consistent in the limit when the regularization parameter goes to zero. In particular, we find a new proof of the existence of maximizing entropic-potentials and therefore, the existence of a solution of the Schrödinger system. Our method extends also when we have more than two marginals: the main new result is the proof that the Sinkhorn algorithm converges even in the continuous multi-marginal case. This provides also an alternative proof of the convergence of the Sinkhorn algorithm in two marginals.

### 15) A protein tertiary structure mimetic modulator of the Hippo signalling pathway

* Adihou, H., Gopalakrishnan, R., Förster, T., Guéret, S. M., Gasper, R., Geschwindner, S., Carrillo García, C., Karatas, H., Pobbati, A. V., Vazquez‐Chantada, M., Davey, P., Wassvik, C. M., Pang, J. K. S., Soh, B. S., Hong, W., Chiarparin, E., Schade, D., Plowright, A. T., Valeur, E., Lemurell, M., Grossmann, T. N., Waldmann, H.
* Organic Chemistry, AIMMS, AstraZeneca Sweden, AstraZeneca, Max Planck Institute of Molecular Physiology, Kiel University, Agency for Science, Technology and Research, National University of Singapore, Guangzhou Medical College, Dortmund University
* Nature Communications
* https://doi.org/10.1038/s41467-020-19224-8
* Corresponding author: Waldmann, H.
* Published 1 Nov 2020 (early online None)
* Processed: 2020-11

Transcription factors are key protein effectors in the regulation of gene transcription, and in many cases their activity is regulated via a complex network of protein–protein interactions (PPI). The chemical modulation of transcription factor activity is a long-standing goal in drug discovery but hampered by the difficulties associated with the targeting of PPIs, in particular when extended and flat protein interfaces are involved. Peptidomimetics have been applied to inhibit PPIs, however with variable success, as for certain interfaces the mimicry of a single secondary structure element is insufficient to obtain high binding affinities. Here, we describe the design and characterization of a stabilized protein tertiary structure that acts as an inhibitor of the interaction between the transcription factor TEAD and its co-repressor VGL4, both playing a central role in the Hippo signalling pathway. Modification of the inhibitor with a cell-penetrating entity yielded a cell-permeable proteomimetic that activates cell proliferation via regulation of the Hippo pathway, highlighting the potential of protein tertiary structure mimetics as an emerging class of PPI modulators.

### 16) Is it worthwhile to go beyond the local-density approximation in subsystem density functional theory?

* Grimmel, S. A., Teodoro, T. Q., Visscher, L.
* Theoretical Chemistry, AIMMS, Vrije Universiteit Amsterdam, Vrije Universiteit Amsterdam
* International Journal of Quantum Chemistry
* https://doi.org/10.1002/qua.26111
* Corresponding author: Visscher, L.
* Published 1 Nov 2020 (early online 11 Dec 2019)
* Processed: 2020-11

Frozen density embedding (FDE) theory is one of the major techniques aiming to bring modeling of extended chemical systems into the realm of high accuracy calculations. To improve its accuracy it is of interest to develop kinetic energy density functional approximations specifically for FDE applications. In the study reported here we focused on optimizing parameters of a generalized gradient approximation-like kinetic energy functional with the purpose of better describing electron excitation energies. We found that our optimized parametrizations, named excPBE and excPBE-3 (as these are derived from a Perdew-Burke-Ernzerhof-like parametrization), could not yield improvements over available functionals when applied on a test set of systems designed to probe solvatochromic shifts. Moreover, as several different functionals yielded very similar errors to the simple local-density approximation (LDA), it is questionable whether it is worthwhile to go beyond the LDA in this context.

### *17) Scientific Perspectivism in Secondary-School Chemistry Education: Integrating Concepts and Skills in Chemical Thinking*

* Landa, I., Westbroek, H., Janssen, F., van Muijlwijk, J., Meeter, M.
* Team Secondary Education, LEARN! - Learning sciences, Innovations in Human Health & Life Sciences, AIMMS, Educational and Family Studies, VU University, Leiden University
* Science and Education
* https://doi.org/10.1007/s11191-020-00145-3
* Corresponding author: Westbroek, H.
* Published 1 Oct 2020 (early online 7 Aug 2020)
* Processed: 2020-10

The importance of learning chemical ways of thinking is widely recognized. Various frameworks have been developed to address the essence of chemistry and chemical thinking. However, very few studies h ...

### *18) Innovation in pharmaceutical R&D: mapping the research landscape*

* Romasanta, A. K., van der Sijde, P., van Muijlwijk-Koezen, J. E.
* Innovations in Human Health & Life Sciences, AIMMS, Organization & Processes of Organizing in Society (OPOS), Network Institute, Organization Sciences
* None
* https://doi.org/https://doi.org/10.1007/s11192-020-03707-y
* Corresponding author: Romasanta, A. K.
* Published 10 Oct 2020 (early online None)
* Processed: 2020-10

In response to the increasing number and breadth of innovation studies on the pharmaceutical industry, we mapped the literature to show the trends in recent research and to indicate areas for further ...